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Blood Oxygen Saturation Determined by Transmission Spectrophotometry of Hemolyzed Blood Samples

The problem:

To develop a simplified method of determining blood oxygen saturation of hemolyzed blood samples. It is well known that the attenuation of light caused by a real sample of an absorbing material is a function not only of its extinction coefficient at the wavelength used, but is also a function of the concentration of the material in the sample and the thickness of the sample. The method should use as its basis the difference in optical absorption properties of hemoglobin and oxyhemoglobin.

The solution:

Base the method on the Lambert-Beer Transmission Law which states that light traversing an absorbing medium suffers an exponential (logarithmic) reduction in its intensity. Use the differences in the absorption spectra of the samples to make the determination.

How it's done:

To convert highly turbid whole blood samples to nonturbid hemoglobin solutions which obey the Lambert-Beer Transmission Law, it is first necessary to break apart the red blood cells, liberating the hemoglobin contained therein (a procedure referred to as hemolysis), thereby converting the suspension of red blood cells in plasma to a uniform solution of hemoglobin pigments. This hemoglobin solution consists of a mixture of oxygenated hemoglobin (oxyhemoglobin, HbO_2) and nonoxygenated hemoglobin (reduced hemoglobin, Hb). The oxygen saturation of the solution is defined as that fraction of the

total hemoglobin present in the oxygenated form.

Nonturbid hemoglobin solutions are absorbing media that follow the Lambert-Beer Transmission Law. The propensity of an absorbing material to produce "extinction" of the light traversing it is quantified in spectrophotometric notation as its "extinction coefficient." The extinction coefficients are wavelength dependent. The differences in the absorption spectra of the reduced and oxygenated form of hemoglobin form the basis upon which the spectrophotometric determination of oxygen saturation is made.

In practice, the transmission of light through a hemolyzed-blood sample is measured at an isosbestic wavelength and nonisosbestic (signal) wavelength. (An isosbestic wavelength is defined as a wavelength at which the extinction coefficients for Hb and HbO_2 are identical.) These two measurements are also performed with a cuvette filled with water rather than hemolyzed blood. The differences between the intensity measurements performed upon the hemolyzed-blood-filled cuvettes and the water-filled cuvettes establish the optical densities of the samples. The percent hemoglobin oxygen saturation can be found from the ratio of the two optical-density measurements.

Note:

Inquiries concerning this invention may be directed to:

Technology Utilization Officer
Manned Spacecraft Center
Houston, Texas 77058
Reference: B67-10252

(continued overleaf)

Patent status:

Inquiries about obtaining rights for the commercial use of this invention may be made to NASA, Code GP, Washington, D.C. 20546.

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